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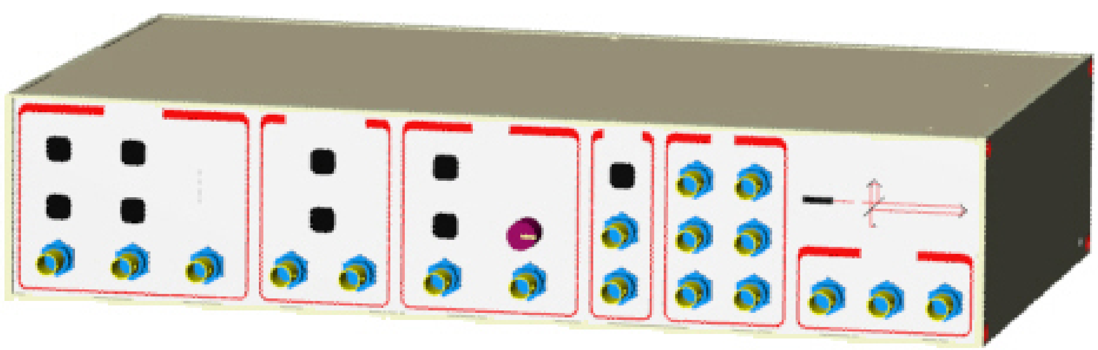
System Interface Module (SIMM) User's Manual



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1 INTRODUCTION

1.1 Design

The FG5 electronics is a flexible system designed to easily operate the FG5 absolute gravimeter. This system interfaces with the system controller (computer) providing analog and digital input and output, and the system also operates the dropping chamber and Superspring.

Note that the *g* Absolute Gravity Software is described in detail in a separate, *g* User's Manual.

1.2 Optional Remote Gravimeter Operation Package

Note that there also exists an optional remote FG5 operation package (see the Tele-g Remote Gravimeter Operation System Manual). In addition to accessing *g*, the gravity measurement software, the remote package also has its own software program *Tele-g* that allows the monitoring of a large portion of the system components. These include:

- The system tilt (verticality)
- Superspring position
- Superspring mode
- Dropper "tuning"
- Dropper mode
- Interferometric fringe amplitude measurement

In addition, the Remote Operation System allows a few parameters to be adjusted through the *Tele-g* interface. These include

- Resetting the tilt position (and thus verticality) back to zero.
- Changing the superspring position
- Enabling/Disabling the Superspring servo
- Changing the dropper controller mode

2 The "System Interface Module"

The electronics are housed in the System Interface Module (SIM). This unit replaces the separate Patch Panel, Superspring Controller, and Dropper Controller of previous FG5 systems. Functionally, the SIM can be divided into five sections:

- The Dropper Controller
- The Superspring Controller
- The Auto-Level Controller (if Remote Operation Package is installed).
- The Patch Panel to the *g* software.
- The Patch Panel to the *Tele-g* software (if Remote Operation Package is installed).

2.1 The Outputs

The output portion of the SIM is displayed in Figure 1.

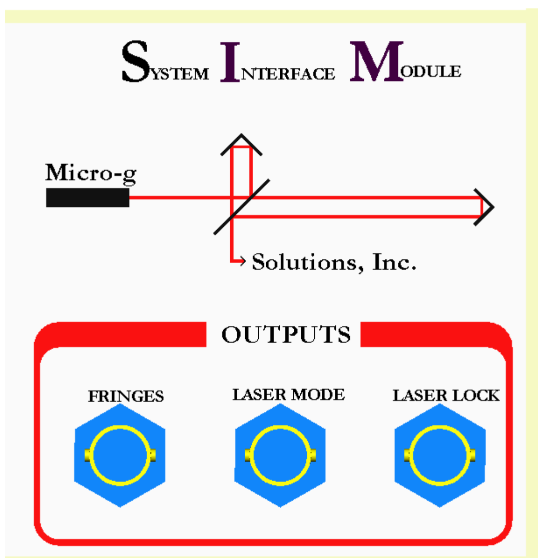

Figure 1. The Output Portion of the SIM. This provides an output of the analog fringe signal, and connections to an (optional) ML-1 laser.

"Fringes" provides an output of the analog signal measured at the photo-detector in the interferometer. This is identical to "Analog" on the actual interferometer. By placing the dropper in OSC mode (see Section 2.2 for discussion of the dropper controller), the fringe amplitude can be measured here. See the FG5 Operator's Manual for discussion of fringe optimization.

The laser mode and lock are for communication with an (optional) ML-1 HeNe laser. (See ML-1 Manual for details.)

2.2 The Dropper Controller

The dropper controller portion of the SIM is displayed in Figure 2.

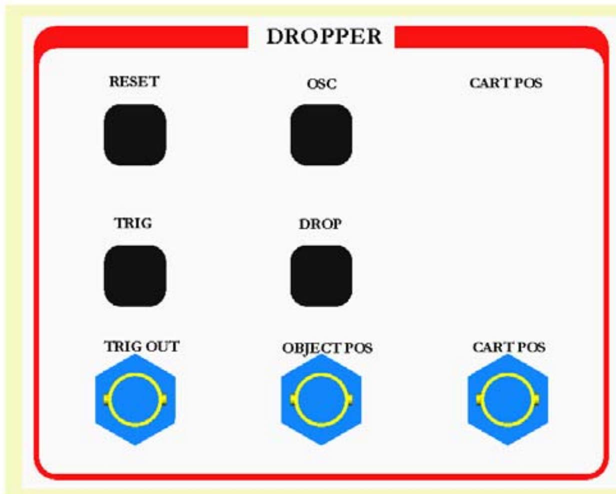

Figure 2. Dropper Controller Section of the System Interface Module.

2.2.1 Theory of Operation

The dropper controller uses two modes to operate the dropping chamber. These modes are OSC and DROP. The operator controls the status of these modes and also the dropper triggering with the RESET and TRIG switches.

In DROP mode, the dropper controller directs the motor in the Dropping Chamber to lift the cart and test mass to a specified height, to move the cart at a specified velocity, and to track the test mass during free-fall.

The motor drives the cart/test mass assembly by turning a pulley and stainless steel drive belt which is attached to the cart. The motor also turns an optical shaft encoder that provides accurate information to the dropper controller on the position and velocity of the pulley.

Information on the relative position of the test mass to the cart during free-fall is provided by comparing the interferometric fringe output (position of the test mass) with the shaft encoder information (position of the cart). The dropper controller uses this information to determine whether to maintain, increase, or decrease current to the motor to achieve the appropriate relative position of the cart and the test mass. This feedback system is a conventional analog servo system.

In OSC (oscillation) mode, the cart slowly moves the test mass up and down to generate slow and uniform optical fringes in the interferometer. An oscilloscope attached to "Fringes" in the output portion of the SIM can be used to measure the fringe amplitude. The position of the cart is indicated by the CART POS LEDs. To automatically stop OSC mode, simply press TRIG or DROP, and the cart will stop at the bottom of the next cycle. Do not press RESET as this will place the cart into freefall which could possibly damage the test mass.

2.2.2 Operation using the SIM

Default mode of the dropper controller at power-up is RESET. When in RESET mode, the dropper cannot be made to either oscillate, lift, or drop. Pressing RESET at any time will immediately drop the cart to the bottom of its travel.

Pressing DROP will put the dropper in drop mode. In this mode, pressing TRIG will:

- Cart at the bottom. TRIG will lift the cart to the top of its travel
- Cart at the top. TRIG will initiate the drop sequence in which the cart places the test mass in freefall and then gracefully catches it at the bottom

The dropper should be in DROP mode for data acquisition. Again, the CART POS LEDs will indicated the position of the cart.

There are three BNC outputs for the Dropper Controller. TRIG OUT sends out a logic pulse when the drop has been initiated. This is normally used to trigger the Time Interval Analyzer card in the system controller (computer). OBJECT POS can be used to read out the position of the test mass relative to the cart. As the distance increases during the freefall portion of the drop, the voltage output increases. CART POS can be used to read out the position of the cart relative to the dropping chamber.

2.3 The Superspring Controller

The Superspring Controller section of the SIM is shown in Figure 3.

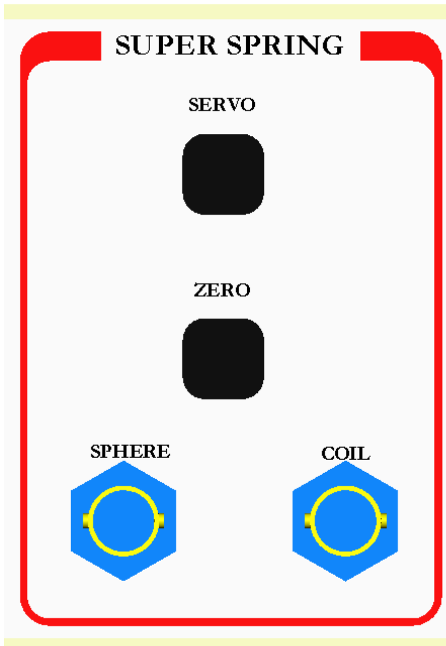

Figure 3. Superspring Portion of the System Interface Module.

2.3.1 Theory of Operation

The purpose of the electronic and mechanical systems for the superspring is to isolate the reference mass from any vertical motion of the instrument in order to keep the path length of the test beam constant. Three systems provide coarse and fine adjustment of the spring support structure: a motor attached to the top of the mainspring, a linear actuator coil and magnet system, and an aneroid wafer assembly. A controller circuit board drives the motor and the coil and magnet system, while the aneroid wafer assembly responds automatically to temperature changes.

A sphere detector system similar to the one used in the Dropping Chamber provides information on the position of the reference mass relative to the mainspring support system. An infrared LED and a photo detector are mounted opposite each other inside the mainspring support housing. A sphere attached to the bottom of the mass focuses the light from the LED onto the detector, which transmits the resulting signal to a sphere signal preamplifier.

The zero-position of the sphere on the test mass can be adjusted by moving the top of the main spring with a small DC motor with a very large gear ratio for fine control.

The main servo electronics control, the coil-magnet forcer, moves the main spring support in such a way to keep the main spring length constant. This active servo effectively weakens the main spring, synthesizing a long period isolation device. The active period of the superspring is nominally about 60 seconds.

2.3.2 Operation using the SIM

ZERO is used to automatically position the superspring corner-cube in the center of the detector range. With the Superspring travel lock disengaged, monitor the SPHERE position using a voltmeter. Once the voltage has settled down to a few 10s of mV, enable ZERO. The spring should come to within approximately 20 mV of zero.

SERVO is used to enable the servo circuit on the superspring. The two functions are mutually exclusive: one cannot zero the spring while the servo is enabled, and vice-versa. Once the spring has settle down near the zero position, enable SERVO.

There are two BNC outputs in the Superspring controller. SPHERE is a voltage proportional to the location of the superspring corner-cube. Ideally this is within 100mV or so of zero. COIL is a voltage proportional to the current being applied to the coil-magnet mechanism. Ideally, after the spring has come to equilibrium, this is constant at zero. See the FG5 manual for details.

2.4 The Tele-g and g Software Interfaces

The software portion of the SIM is shown in Figure 4.

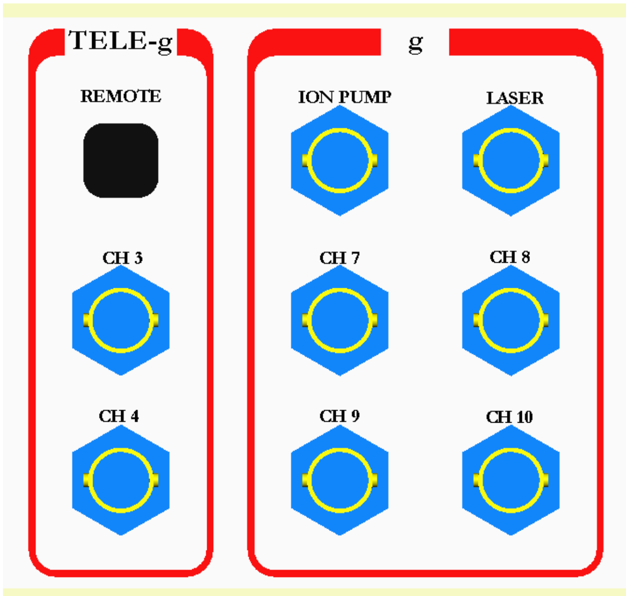

Figure 4. The "Tele-g" and "g" Software Interface.

The BNC connectors in this section are all inputs. The Ion Pump and Laser inputs are used in the *g* software for diagnostic purposes. CHs 3,4 and 7-10 are auxiliary inputs for user defined functions or future upgrades.

For past FG5 users, note that the rest of the connections (barometer, triggers, Superspring sphere) are now all connected internally.